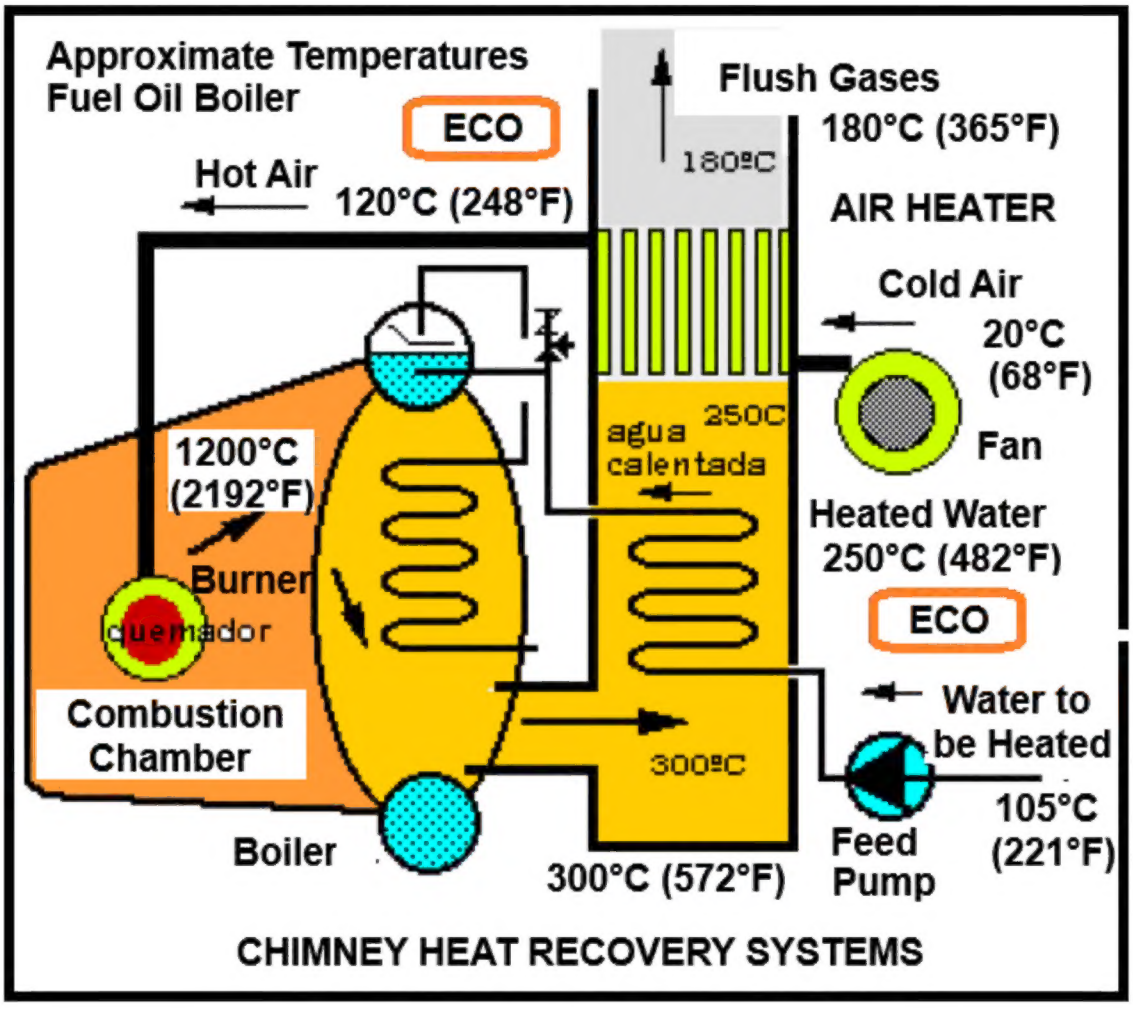
# CHAPTER 16: HEAT RECOVERY SYSTEMS
# THE AIR HEATER AND THE ECONOMIZER

Heat recovery from flue gases is done to improve the utilization of heat that would otherwise be lost. Generally, the gases exiting the last pass of the boiler, regardless of the fuel, are at a temperature
50°C (122°F) to 100°C (212°F) higher than the saturated steam in the boiler.

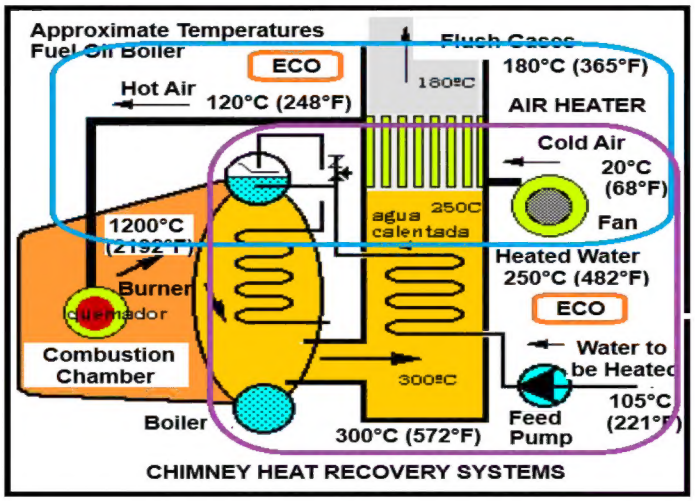
Since the boiler has a heat exchange limit (which depends not only on the heat transfer surface area but also on the available temperature difference, i.e., the temperature difference between the combustion gases and the saturation temperature at the boiler's operating pressure).

This means that beyond a certain point, increasing the boiler's heat transfer surface area is either not feasible or not economically viable.
Therefore, heat recovery systems must be used, which utilize fluids at a lower temperature than the water inside the boiler.



These low-temperature fluids can be:

**The relatively cool feedwater (the economizer or "ECO") or the air used for combustion** (the air heater, which improves combustion conditions, especially when burning wood in logs).




Although other fluids could be heated for different uses, provided the temperature difference allows it.

Heat recovery in a boiler's chimney improves performance or efficiency to a significant degree, which can vary depending on local conditions, boiler type, and fuel type (this recovery can generally range from 3% to 10%).

In the case of the economizer (ECO, boiler feedwater heater), there are two problems to address: internal corrosion and scaling (the water must be chemically treated) and the problem of external corrosion or corrosion in the flue gas zone.

With the sulfur in the fuel, it forms SO2 and SO3, which then form sulfuric acid with the moisture from the water produced during combustion (oxygen, when it combines with hydrogen, forms H2O, or water).

This type of corrosion will occur in both the ECO and the air heater if the gas temperature drops to the dew point.

This is the temperature to which the gases must be lowered to form water droplets; this temperature will be higher as the amount of sulfur in the fuel and the amount of water in the gases increase, as well as the amount of "unburned" gases, usually "pyroligneous" acids - acetic, formic, etc.).

To prevent sulfur corrosion in both the ECO and the air heater, the water or air will have to be preheated to avoid areas where the temperature of the metal on the gas side reaches or drops to the dew point.

For example:
in general when working with heavy F. Oil which contains a lot of sulfur, the minimum temperature in the gases should be no less than 180ºC (356°F).

This sulfur problem continues to attack the iron components during shutdowns because acid remains in the ash, refractory materials, or deposits that may form in the areas of the heat exchangers and air heaters.

During extended shutdowns, it is advisable to wash both heat exchangers with hot water slightly alkalized with soda and then dry them with indirect heat. Maintain a dry atmosphere during the shutdown, using heat or another method, but never leave them damp after washing.

Additionally, it is advisable to close the outside air circulation by sealing the chimney to prevent the entry of humid air.

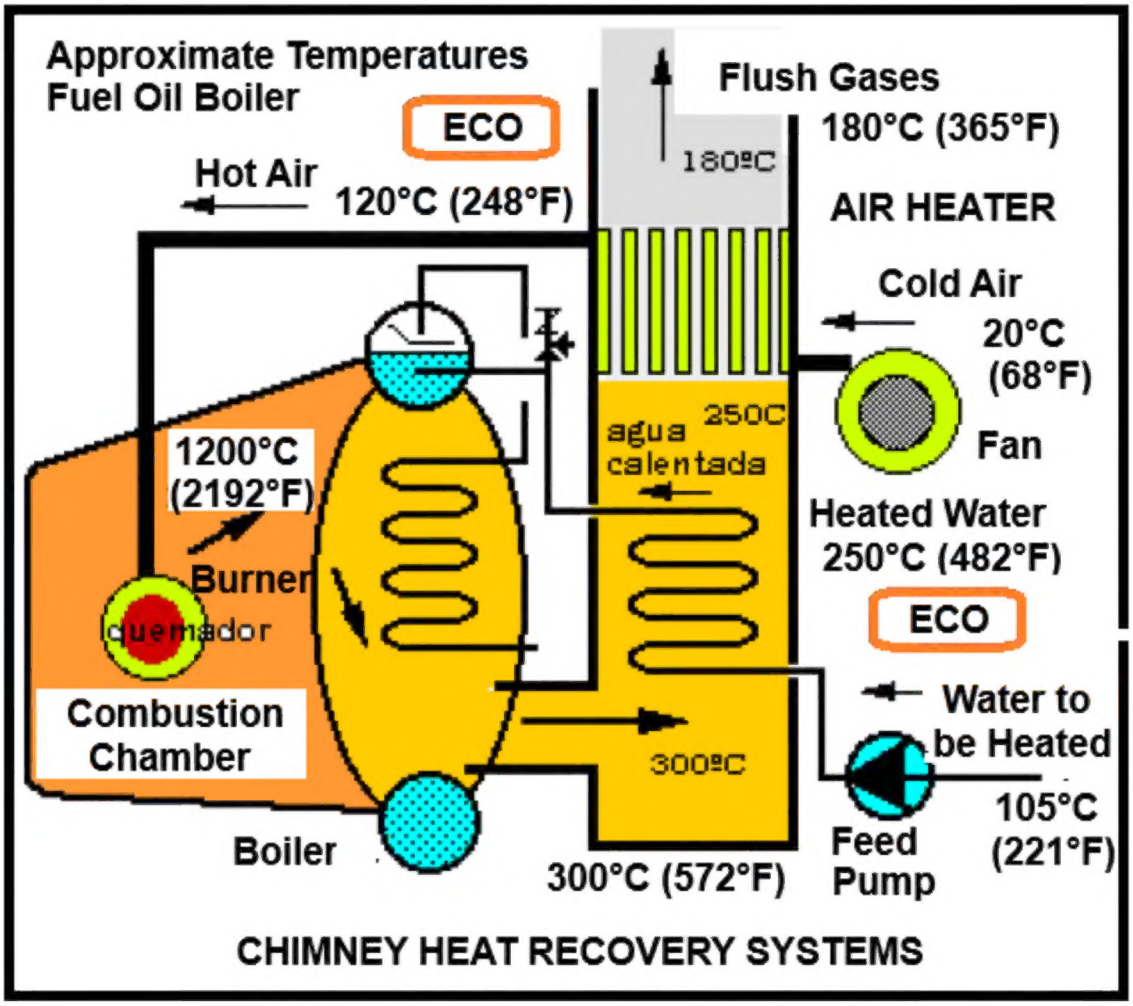
This entire corrosion problem has led to the creation of ECOS and air heaters made of more corrosion-resistant materials (even glass has been used in air heaters).

These high-quality materials perform well, but they still require cleaning on the flue side.

This is because some fuels (except natural gas and other gases that burn cleanly without producing soot) deposit soot or ash in these relatively cooler areas, causing poor heat exchange and hindering gas flow.

In the ECOS, this problem is exacerbated, especially when they are finned on the flue side to increase the heat exchange surface, since the heat transfer coefficient on the flue side is lower than on the water side.

One way to clean these exchangers, in some cases, may be the use of hot water (creates a problem of acidic effluents in F. Oil), during a momentary stop, otherwise in other cases soot blowers with steam or compressed air may be implemented (creates a momentary contamination at the gas outlet).




With some "clean" burning fuels, free of sulfur or other contaminants (such as soot, ash, etc.), as is the case with some gases (with good combustion, no soot, and no unburned gases), it's possible to utilize even the latent heat of the water present as steam in the gas stream (for this, the gases are "scrubbed," and this water, which has accumulated latent and sensible heat, is exchanged).

In industry, the challenge lies in finding sources of energy utilization at low temperatures (such as heating water for industrial use, space heating, or other applications), which isn't always easy to find, since there are other losses at higher temperatures (such as steam condensate, its "flash," which is surplus and has no application since process temperatures are sometimes higher).

The other problem to consider is that if the flue gases are excessively cooled, they will not rise on their own, which leads to environmental pollution near the

flue gas discharge area.

In economizers (ECOs), water circulation must be continuous and upward (to prevent the formation of "steam pockets").

If the feed is on and off (intermittent), the stagnant water in the ECO will vaporize, causing corrosion, salt deposits, and excessive metal temperature with oxidation.

This can result in slow and even "rapid" combustion. The latter, fueled by the backflow between the steam and the metal of the ECO, can generate so much heat that it melts the ECO. It should not be extinguished with water; in fact, ships have sunk when the boiler and its containment material melt, perforating the ship's hull.

**Stoker Boiler Handbook 2011, C.W.T. – CHAPTER 16: AIR HEATER AND ECONOMIZER**

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